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ABSTRACT

Research on Trait by Treatment Interaction must become more coordinated. It should include systematic programs by individual investigators as well as those among investigators. Important factors to consider are (1) developing a clearer definition of traits which will include availability and preference as well as aptitude and ability in both the cognitive and non-cognitive domains; (2) analyzing the processes employed by learners in given learning situations rather than of the nominal characteristics of the learning situation itself; and (3) constructing theories of statement describing interlocking relations between traits, processes and environments with the recognition that these function in dynamic ways. (Author/DJ)

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THEORY AND MEASURES OF INDIVIDUAL DIFFERENCES IN STUDIES OF TRAIT BY TREATMENT INTERACTION*

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Abstract

Research on TTI must become more coordinated than at the present. It must take the form of systematic programs by individual investigators, as well as among investigators, in which the following are considered: Clearer definitions about what is implied by the construct "traits" are needed. The suggestion is made that the definition of "traits" should include availability and preference as well as aptitude or ability in both the cognitive and non-cognitive domains. Traits, aptitudes, and the like, built on the earlier prediction model of assessment (in which a high degree of generalizability of traits was assumed) appear to be inadequate for TTI studies. Analyses must be made of the processes employed by the learners in given learning situations, rather than of the nominal characteristics of the learning situation. Conceptualizations about processes and their products from current cognitive theories seem to be of particular importance. In addition new constructs will have to be devised for describing processes employed by learners and for describing the process demanded in specific tasks. There is urgent need for taxonomies of how situations are coded by learners and for generalizations about the kinds of transformations or coding processes learners make in learning situations as well as taxonomies extended to instructional as well as laboratory settings. As complicated as this task might be it seems to be an essential one if adequate TTI theories are to be constructed. Assessment must be uniquely adapted to considerations related to the status and change of processes employed by learners. From the standpoint of methodology, it

is critical that studies are designed in a manner which gives the interaction a chance to operate. A highly constrained experimental situation may yield treatment effects but may not permit individual differences to function. Finally, theories must be constructed of statements describing interlocking relations between traits, processes, and environments with the recognition that these function in dynamic ways.

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When an enthusiastic investigator begins his first research on Traits x Treatment Interactions (TTI) his inclination is to translate the three terms as though they represented a complete model rather than a skeleton of the model. He administers a battery of tests, manipulates a treatment, obtains some criterial measure of performance or achievement, and analyzes the data for interactions (I) between the trait(s) (T) and the treatment(s) (T) he has varied. (Often he neglects to note that the TTI model is a methodological rather than a substantive model.)

The procedure follows a formula: First, the treatments are manipulated in oppositional fashion, e.g., group versus individual settings; smooth versus rough presentation; fast versus slow pacing; or pictorial versus verbal stimuli. Thus, the stimuli, the task requirements, or the setting in which the task is to be performed are varied so as to permit the greatest contrasts. Second, the test battery is comprised of tests that seem to be related to the treatment, often superficially so. Thus, if fast vs. slow pacing was used for his treatment he migh have selected individual difference measures of impulsivity and reflectivity; if smooth versus rough presentation were his treatments he might have selected measures of high and low intellectual ability. Two or three other tests might be included on the test battery to make provision for establishing construct validity. Third, criterion measures are selected which reflect the hypothesized influence of specific

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variables on performance, including measures of rapidity of learning (e.g., trials to criterion), latency of response, kind of learning (e.g., rote memory or transfer), or achievement (e.g., number of correct responses). Fourth, the investigator may attempt to establish generalizability of his results. If so, Type I replications are used to investigate the stability of the interaction in other samples of subjects from the same population or in samples of subjects from other populations. Type 2 replications are used if the investigator wishes to move the interaction from task-specific relatedness with the individual difference variable to more general characterization of the task along some specified continuum; i.e., he may attempt to move the interaction to more general ground.

This approach was a reasonable starting point in the study of TTI. Many of its features are, of course, methodologically sound. In its emphasis on S-R relationships and task specific measures of traits it provided the basis for analysis of situations and the eventual development of theory. One weakness may have been that upon meeting failure at replication the investigator failed to pursue the necessary theoretical analyses, in the face of his new data, upon which sounder formulations can be constructed. He often turned from one topic to another, perhaps at a superficial level, in order to minimize the risk of further failure in identifying Trial x Treatment Interactions. He thereby neglected the serious business of engaging in a systematic series of studies in a single area with the aim of capitalizing on information gained, and errors made, for planning extensions of his research program.

Then what <u>are</u> the next steps? I propose that we must <u>analyze</u> the <u>processes employed by learners</u> confronted with learning tasks in the laboratory or classroom and hypothesize precisely the ways in which these processes are

related to situations and to aptitudes (traits), i.e., we must engage in theory construction which at the start will necessarily be miniature models. It is commonplace these days to assume that in most learning situations, learners are "busily engaged." There is much evidence to support this assumption. Learners attend to, scan, and search through, the material to be learned. They form rules and they use their own individual strategies in processing the input. The point to be made here is that the stimulus input is comprised of nominal stimuli, i.e., task requirements assumed by the experimenter to be the ones attended to by the learner. That this is not the case is now commonly accepted among psychologists and educators. We know that the learner's final performance is dependent on the effective stimuli, i.e., the subject's view of task requirements, and these are determined at the least, by (a) what he attended to, if he did, indeed, attend to the material; and, (b) how he processed the material.

The way the learner processes the material to be learned, his reactions to approval, his reactions to teacher characteristics, and the like, during processing activity and, perhaps, in the selection of the processing activity, are important places where traits can be assumed to have their differential effects. We can see, for example, that learners engaged in the task of recalling numerous single items in the study-recall procedure can proceed in a number of ways: they may try to remember them in arbitrary fashion, they may impose some artificial organization, such as alphabetical sequence, on the materials; they may form images or sentences; or they may cluster them in terms of associative or semantic relationships to name but a few possible strategies for processing. Some subjects follow the experimenter's instructions religiously, others try to outguess him and look for hidden meanings and purposes for the experiment, and still others ignore the experimenter's instructions and follow their own ways. In most laboratory experiments, we

try to manipulate these variables or to control for their effects. In TTI investigations these are some of the places in which the influence of individual differences on performance are hidden. Although there may be some question regarding the extensiveness of processing, it is my impression that the affective and psychomotor domains are as influential and are influenced as much by coding (processing) operations as is the cognitive domain. For example, what learners attend to is often a matter of their attitudinal predispositions, and, if we accept Miller, Galanter, and Pribram's notion of the affect of plans on learning motor skills, then we are speaking of intervening processes in both attitude formation and in the learning of skills.

An emphasis on process in slightly different form was made by Melton (1967), was elaborated in a descriptive model of instruction by Di Vesta (1972) and was reemphasized in an article by Glaser (1972) in Educational Researcher. Overall, four methodologies can now be seen as viable ones: the traditional experimental approach in which treatments are related to outcomes; the traditional correlational approach in which generalized traits are correlated with outcomes; the current cognitive approach in which treatments are viewed in terms of their effects on process and subsequent outcomes; the TTI approach in which traits as generalized behavioral tendencies, interact with treatments to affect outcomes; and an approach in which traits, reflecting processes employed by the learner for approaching given tasks, (TTPI) affect outcomes. These four methodologies may be depicted graphically as shown in Figure 1.

I have said that the construct of traits, as commonly construed, is too general to provide much of a guideline to the investigator. To many investigators, trained on the prediction model of assessment, this construct refers to a static generalized aptitude or ability. From the standpoint of theory in

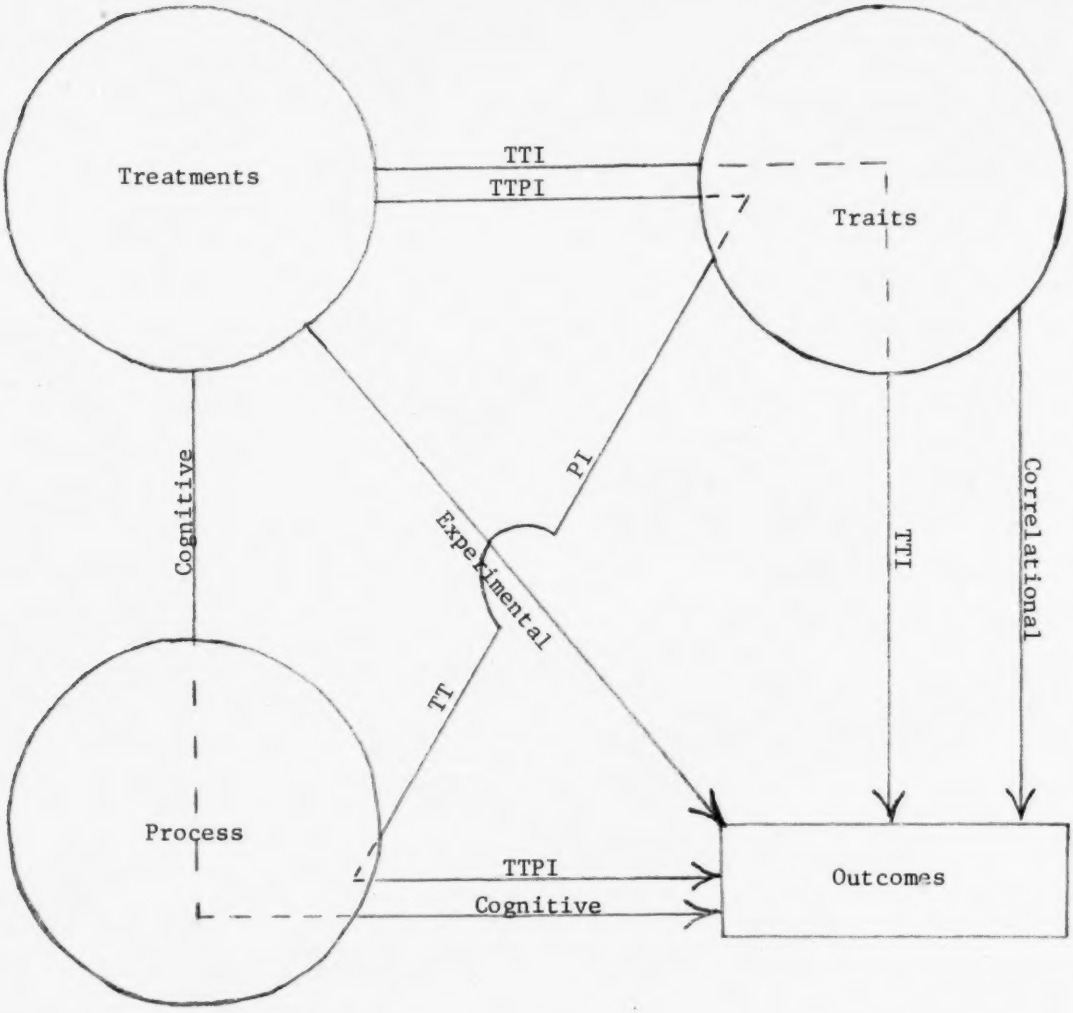

Figure 1. A graphic representation for generalized experimental models.

TTI we should make further distinctions including ability to use a rule or strategy, availability (perhaps even a distinction between availability and accessibility must be made) of a rule or strategy, and preference or choices among rules or strategies. Note that the term preference refers to choices among cognitive strategies and not to preferences as interests in the traditional measurement sense. Learners do have a history of using certain strategies over others, they develop some abilities in using some strategies to a greater extent than others, and they learn to compensate for deficiencies through their histories of compensation. Accordingly, "traits" encompass the entire range of cognitive and non-cognitive dispositions.

From the standpoint of theory construction in TTI these distinctions can make the difference between a "successful" and "unsuccessful" experiment. Most college students have a number of strategies available to them. They can use the strategies with varying degrees of skill. But if the investigator provides sufficient constraints on the performance of the task, learner's may be forced to employ one strategy to the exclusion of another in which case experimental manipulations tend to dominate any influence that individual differences might have. On the other hand, given treatments in which there is opportunity for a number of strategies to be employed, individual differences in availability, ability, or preference should yield the interaction effects that are implied by TTI. With the freedom to learn in the way one wishes, with what materials, and on what tasks, individual differences will have observable effects on the learner's use and choices of processes.

I would like to illustrate some of these matters regarding information processing by learners and their implications for studies of TTI from our own studies of imagery. We began with the assumption that some people form images and others use verbalizations while learning, i.e., learners may (because of

ability or preference) process the material to be learned in the form of mental pictures or verbal frameworks, whether associative, sentential or semantic. On a superficial input-output level of theorizing one might hypothesize that high-imagers will profit more than high verbalizers from exposure to pictorially presented materials while high verbalizers will profit more than high imagers from materials presented verbally. This is a currently prevalent and widely accepted assumption. However, examine the notion further. Why should there be a difference between imagers and verbalizers, at least among college students, in the performance of tasks involving pictures or concrete verbal materials? After all, norms for concreteness and imagery of learning materials are obtained from subjective ratings by general populations concerning their ability to form images of these materials and concerning their view of whether these materials are concrete or abstract. It is probably safe to say that concrete materials are easily learned via either imagery or verbal processes: Pictures can be transformed into their verbal counterparts by verbalizers, so low imagery ability is a minimal handicap. Conversely, concrete verbal materials, by definition, can be formed easily into imaginal representations so low verbal ability is a minimal handicap. Assuming that imagery and verbalizing are critical processes, differences between the two groups wash out in designs based on tasks in which concrete materials are employed.

What is the remedy? I submit that the investigator must employ the strategy of taxing whatever processes are assumed to intervene between the experimental situation and the learner's observed behavior. Furthermore, when that process is taxed it's use must be at the expense of a hypothesized opposing process. Thus, an experimental situation is designed in which subjects must be made to depend on one process to the exclusion of the other. In

imagery studies, this end might be achieved by employing pictorial materials which are least likely to have a verbal counterpart and which are least likely to be verbally labeled. Performance, too, would be evaluated by accuracy of the pictorial representations made by subjects. Such procedures should favor the imagers if the hypothesis is a viable one. Conversely, we might use highly abstract verbal materials which have little possibility of being represented graphically. This procedure should tax the ability of imagers and should put the verbalizers in their own ball park.

A parallel procedure might be one in which only one set of materials might be used, i.e., abstract verbal materials which can be depicted graphically, but with some difficulty. Specialized ratings of words, sentences or thematic material would have to be obtained for this purpose. In any event, our experimental treatments would require the imagers and verbalizers to process the material (i.e., to transform it) by imaging in one treatment and verbalizing in the other. The imaging process then should favor the imagers and verbalizing should favor the verbalizers. Sharpening of performance criteria (e.g., extent of elaboration, conciseness of representation) would be required for more precise evaluation of effects. Regardless of the elegance of whatever design we employ, our theories will profit by feedback, at the conclusion of an experiment, from the very simple device of asking learners just what it was they did in the treatments we manipulated. Alternatively, we might provide them with information about all treatments of a design and ask them to identify which treatment they were in. Investigators using these feedback procedures may come up with some surprises about their manipulations of treatments. (This latter point is not to be misconstrued as a return to introspectionism. Rather it is described only as one procedure to provide an indication of the validity of the induction of treatments.)

The use of theory also helps in identifying both the interesting effects that go beyond commonsense and in identifying variables that might otherwise go unnoticed. Take, for example, Berliner's (1971) interesting analysis of learning from instruction. By careful analysis he was able to demonstrate that when memory aptitude is low, note-taking and paying attention are equally effective. In fact, when memory ability is low attention may sometimes be better than note-taking as a strategy. On the other hand, when memory aptitude is high note-taking is clearly superior to merely paying attention. Schultz and Di Vesta (1972) investigated the behavior of high- and low-dogmatics in a problem-solving situation where endorsement of correct beliefs was made by an authority. The high-dogmatic's ready acceptance of an "authoritative" source's advice enabled them to solve the problem more readily than low-dogmatics who tend to spend time evaluating reliability and validity of the content rather than accepting advice at face value. On the other hand, the high-dogmatics were baffled by ambiguous advice from an authoritative source and were blocked in arriving at a solution; low-dogmatics dismissed the ambiguous advice for what it was and turned to other alternatives, thereby facilitating their solution of the problem. Ingersoll and Di Vesta (1972) showed that preference for aural and visual attending interacted with auditory and visual modes of presentation. But, in addition, the performance of visual-attenders reflected primacy effects, while that of aural-attenders reflected recency effects in the material to be recalled.

The effects described in these illustrations are clearly manifestations of different processing activities. These, and similar studies, have gone beyond the input-trait-output, variables typically considered in TTI. They take into account the way information is processed. But still more comprehensive theories are necessary. The carefully considered framework formulated by

Harvey, Hunt and Schroeder (1961) in their treatment of conceptual systems of personality is an example. They described the individual's development in terms of four stages beginning with highly simplified, restrictive conceptual systems and terminating in highly complex, abstract, and diversified systems. Differential descriptions of behavior at each level were made according to acceptance of information from a source, the acceptance of sources with different characteristics, the kinds of decisions capable of being made at each stage, the manner in which persons at each stage react to stress, and the like. The theory provides a basis for matching personality types to teaching environments and teacher personality. It also provides for means by which the person could be helped to develop from one stage to the next. Obviously, this formulation required an elaborately complex and interlocking set of assumptions about intrapersonality organization and its relationship to external events. It provided the impetus for a number of TTI studies by the investigators and their students, too numerous to describe at this point. In general, their theory has led to conclusions which suggest that different classroom structures must be matched to the conceptual development of the student for efficient learning to occur.

An emphasis on theory must necessarily consider the selection of measures for evaluating traits. The simplest of rules that we all know, but often ignore or neglect, is that one must know what he is measuring in order to know what he is trying to predict (and vice versa). It is a paradox, within our current state of knowledge about test theory, that investigators often will take the validity of a test at face value, assuming that the label given a test literally defines what the test measures. They become trapped by the "tyranny of labels."

I would like to illustrate this point by considering a common error in selecting tests for studies of imagery. When measuring individual differences

in imagery some investigators have used the DAT Spatial Relations and the Flag tests. I have no objection to this procedure provided the investig tor places notions about the tests within reasonable nomological nets based on theoretical assumptions and available information related to the construct validity of the tests. Within such frameworks, high scorers can be reasoned to have more imagery ability relative to low scorers. However, some investigators have equated low scores on these tests with high verbalization ability. I do object to this assumption when it is unsupported by the necessary evidence; and it is unsupported at the present time. While high scores may reflect imagery ability, one does not know just what processes the low-scorer can or does use; it may be verbalization or some other, as yet unidentified, strategy. Without evidence, theory, and nomological nets we can only infer from low scores that the learner has difficulty with manipulating objects mentally in space and nothing more. Carrying this example further, we may question whether performance on other measures, such as the Gottschaldt, taps imagery, spatial, perceptual ability, or some more general trait such as field dependence. Similarly, while the Stroop color-name test and Broverman's (1964) automatization test appear, upon superficial analysis, to require the use of imagery, it is clear when one examines factor analysis data, that the trait tapped is quite different from spatial relations or field dependence. These latter measures seem to be related to automatization, that is, fluency in encoding a visual stimulus in verbal terms. We need only to note here that imagery and other individual difference variables are highly complex when viewed in terms of process analyses. The resulting distinctions imply differential predictions about interactions with treatments.

The importance of establishing the validity of tests within a theoretical framework can be seen further in those studies employing anxiety. Differentiations

between two forms of anxiety (state and trait) have been made by Spielberger, O'Neil, & Hansen (1970) in a closely knit theoretical framework that has led to fruitful investigations within the context of Computer-Assisted Instruction. Other differentiations of anxiety, within other theories, have also been made: for example, manifest or general anxiety has been contrasted with specific anxiety in test situations; and debilitating anxiety has been contrasted with facilitating anxiety. The ultimate utility of these distinctions must await further evidence but they do suggest the limitation of depending upon measures of a single generalized trait when we consider information processing as a feature of TTI. Validation of any individual difference measure by the multitrait-multimethod matrix procedure advocated by Campbell and Fiske (1969) is implied in our reasoning here. This procedure utilizes ". . . a matrix of intercorrelations among tests representing at least two traits, each measured by at least two methods. Measures of the same trait should correlate higher with each other than they do with measures of different traits involving separate methods. Ideally, these validity values should also be higher than the correlations among different traits measured by the same method" (Campbell & Fiske, 1959).

These few selected considerations about theory and tests seem particularly cogent in view of Mischel's earlier (1969) suggestion that we have built much of our study of aptitude and personality in terms of generalized tendencies to the neglect of their interaction with situational variables. In particular, we must look at the dynamic feature of personality, i.e., we "will have to leave as much room for human discrimination as for generalization, as much place for . . . change as for stability" (p. 1017). Change often appears capricious, but as Mischel notes it can be situationally and environmentally determined. A person who has a low IQ does behave intelligently, if not

brilliantly, at times. A person may only be anxious in some situations rather than all. And, low-imagers may have other processes available that will get him through some kinds of tasks when the going gets rough. These notions imply more precise theories about when and where traits will have their effects on performance. Furthermore, they imply relatively complex taxonomies, perhaps by gradually accumulating evidence from empirical studies. I do not believe that valid taxonomies can be constructed by "armchairing."

In summary, research on TTI must become more coordinated than at the present. It must take the form of systematic programs by individual investigators as well as among investigators. Briefly:

(a) We need clearer definitions about what is implied by the construct "traits." I have suggested that it include availability and preference as well as aptitude or ability in both the cognitive and non-cognitive domains. Traits, aptitudes, and the like, built on the earlier prediction model of assessment (in which a high degree of generalizability of traits was assumed) appears to be inadequate for TTI studies.

(b) Analyses must be made of the processes employed by the learners in given learning situations, rather than of the nominal characteristics of the learning situation. Here we may be able to borrow conceptualizations about processes and their products from current cognitive theories. In addition we may have to devise new constructs for describing processes employed by learners and for describing the process demanded in specific tasks. There is urgent need for taxonomies of how situations are coded by learners and for generalizations about the kinds of transformations or coding processes learners make in learning situations; a point made by Melton in 1959 although I would like to say such taxonomies should be extended to instructional as well as laboratory settings. As complicated as this task might be it seems to be an essential one if we are to construct adequate TTI theories.

(c) Assessment must be uniquely adapted to considerations related to the status and change of processes employed by learners. Investigations of TTI are critically dependent on assessment. If inadequate, the investigation is doomed to failure. When ATI studies are based on high- and low-trait groups, it seems to me to be essential that investigators report at least the means and standard deviations of the two groups. This simple but often neglected reporting requirement would permit comparisons among similar studies where interactions were and were not found. Such data may help to identify some of the reasons for replication failures.

(d) From the standpoint of methodology, it is critical that the investigator give the interaction a chance to operate. A highly constrained experimental situation may yield treatment effects but does not permit individual differences to function.

(e) Finally, theories must be constructed of statements describing interlocking relations between traits, processes, and environments with the recognition that these function in dynamic ways. Hopefully, such theories will take us beyond the commonplace or commonsense finding and enable us to identify the unexpected result which, over the long haul, is what the TTI approach is designed to discover.

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